MV Drives, August 2012

ABB drives in mining
Medium voltage drives for reduced energy consumption and optimized process control

Challenges
Accelerating output and reducing production costs

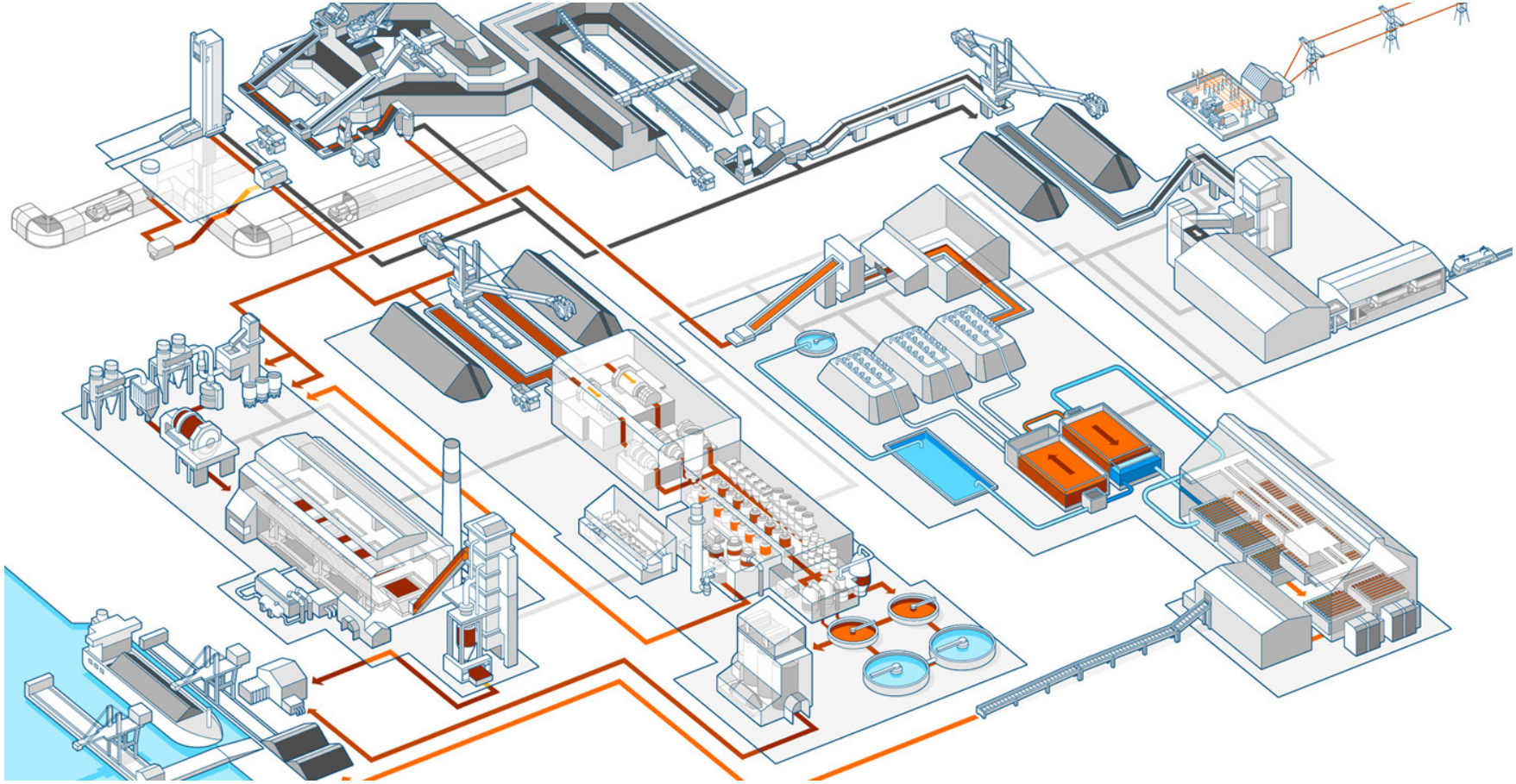
Mining companies face major challenges for sustainable growth. They need to:

- Improve performance
- Cut production costs
- Reduce environmental impact
- Improve safety
- Increase automation
- Cooperate and integrate with community

Variable speed drives (VSDs) optimize process control and save energy.

They are used in a wide range of applications in the mining industry.

Variable speed drives for mining applications



Underground mining

- Ventilation
- Pumps
- Conveyors and mine hoists
- Shearers and armored face conveyors
- Crushers

Open pit mining

- Pumps
- Conveyors
- Excavators
- Shovels and draglines
- Stacker-reclaimers
- Spreaders

Ore concentration

- Fans
- Pumps
- Mills
- High-pressure grinding rolls

Processing and refining

- Fans
- Pumps
- Conveyors

Benefits of variable speed drives

Controlling processes with VSDs has a direct impact on a company‘s operating costs.

- Lower energy consumption and CO_2 emissions
- Minimized mechanical wear of equipment
- Higher process quality and efficiency
- Increased productivity and throughput
- Less investment in electrical network compensation devices, such as filters
- Less use of consumables, like water, chemicals, additives etc

Benefits of variable speed drives
Fixed versus variable speed control

	Electrical	Mechanical
Variable speed	Variable speed drive	Hydraulic coupling
Fixed speed	On-off	Valve, fan inlet vane, damper

- Mechanical fixed-speed solutions
  - Flow is adjusted by a mechanical device, eg fan inlet vanes, dampers, resulting in:
    - Waste of energy
    - Wear out of equipment
- Electric variable speed drives
  - Change in production volume achieved by adjusting the speed and/torque of the motor
  - Equipment will be operated at Best Efficiency Point (BEP), resulting in:
    - Energy savings
    - Decreased CO_2 emissions
    - Minimized operating costs

Benefits of variable speed drives
Energy savings and reduced emissions

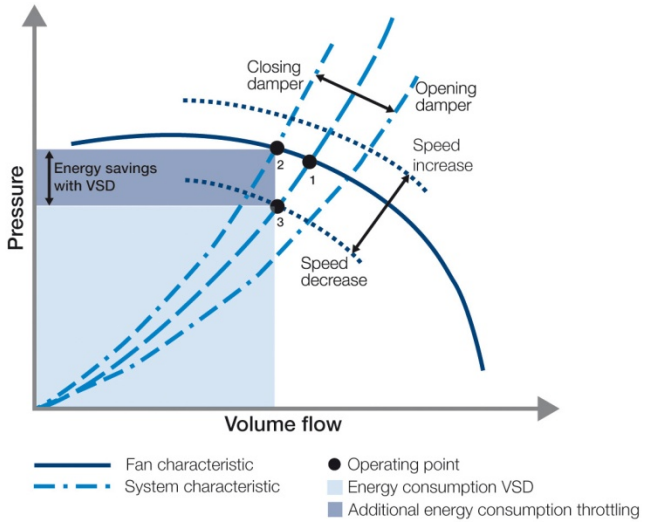
Energy consumption of most motor-driven applications can be reduced with VSDs

- Fans typically run at partial load
- A fan running at half speed consumes less than 15% of the energy compared to one running at full speed
- Energy consumption can be reduced by as much as 60% with variable speed drives
- Variable speed drives help to reduce CO_2 emissions

Benefits of variable speed drives
Reliable performance and longer lifetime of equipment

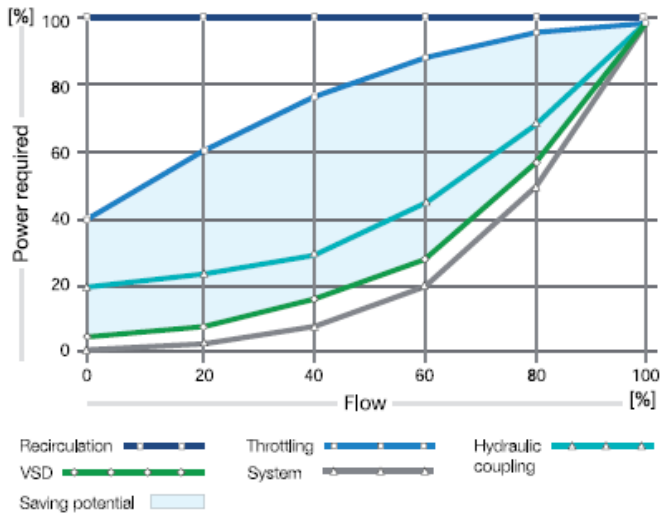
- Full starting torque even under weak network conditions
  - Precise control of torque and elimination of harmful torque peaks
- Power loss ride through
  - ABB drives are able to withstand disturbances on the power supply
- Reduced maintenance costs and longer lifetime of equipment
  - VSDs act as soft starters, reducing the stress on network, motor and process equipment

Applications
Fans



- Changing the operating point with a damper alters the system characteristic, increasing system losses
- Increasing or decreasing the fan speed with a variable speed drive changes the fan characteristic
  - No additional losses
  - Significant energy savings as lower pressure is needed for the same air flow

Applications
Pumps



About 20% of a mine's yearly energy consumption is used by pumps

- Controlling the pump motor speed with a VSD brings substantial energy savings compared to other control methods
- Soft starting with a VSD eliminates pressure peaks in pipelines

Applications
Slurry pumps

- Pumping slurry is one of the most demanding applications for a pump
  - High-density, abrasive and corrosive substances, wear out parts quickly
  - High maintenance and energy costs
- A VSD adjusts the pump speed to match fluctuations in system parameters such as flow rate, static head and settling velocity
  - Prevention of blockages and plant shut down
  - Reduction of energy consumption and maintenance costs

Applications
Mills

Benefits of variable speed drives:

- Optimized plant production
  - More efficient use of grinding power - speed of the mill is tuned for optimal grinding and maximum throughput
  - Mill can be operated at partial load; no process stop required
  - VSDs adjust the speed according to charge volume
- Less wear and higher reliability
  - Direct-on-line start of the mill stresses the mechanical equipment, shortening its lifetime
  - VSDs help optimize the mill speed to match the material flow, minimizing the wear of the mill

Applications
Mills

- Accurate and coordinated load sharing when the mill is equipped with two motors
- Smooth ramp up
  - Low starting currents and high starting torque enable a smooth start-up of the mill, even when fully loaded
  - Reduced stress on network and mechanical equipment

Applications
Conveyors

Benefits of variable speed drives:

- Extended lifetime and increased availability
- Accurate and fast load sharing
- Power factor compensation
- Regenerative braking of downhill conveyors saves energy

Conveyors
Benefits of variable speed drives

- Extended lifetime and increased availability
  - Accurate torque and speed control reduces stress on mechanical equipment
  - Speed of the conveyor can be adjusted to production capacity reducing wear and saving energy
- Accurate and fast load sharing between several drives
  - All motors are loaded as needed if several motors operate on the same conveyor belt
- Power factor compensation
  - With ABB drives power factor is greater 0.95
  - No need for additional power factor compensation
  - Less losses on electrical network
- No inrush currents when conveyors are started
- Regenerative braking of downhill conveyors saves energy
  - The braking energy can be fed into the plant‘s electrical network, thereby generating electricity

Applications
Mine hoists

The uninterrupted operation of a mine hoist is most important to safety and production. VSDs provide:

- Safe and reliable operation
  - Greater equipment control
  - Remote monitoring and diagnostics
  - Half speed, full load redundancy
- Lower energy consumption

Components of variable speed drives

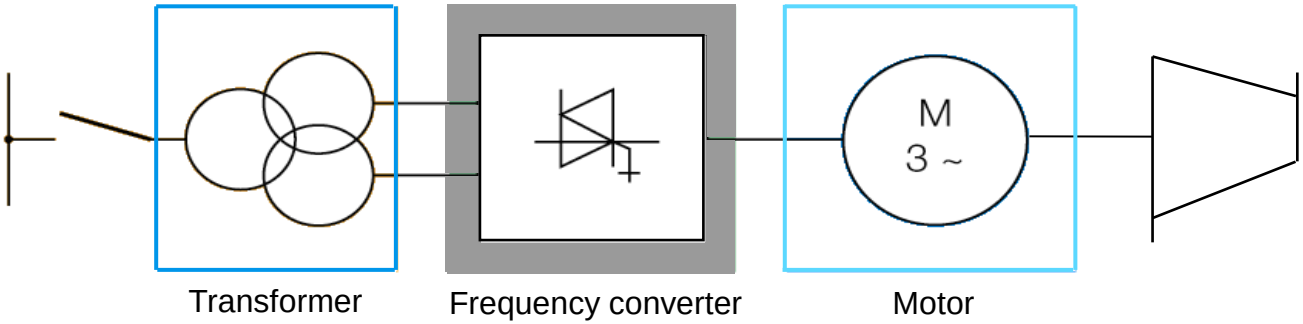


ABB can offer the complete variable speed drive system or assist in selecting components that match the process requirements.

A variable speed drive system consists of:

- Input transformer
- Frequency converter
- Electric motor

Medium voltage variable speed drives

- Power range: 250 kW – more than 100 MW
- Voltage range: 2.1 kV – 10 kV
- Products available for operation with external transformer, integrated transformer or for direct-to-line connection (transformerless)

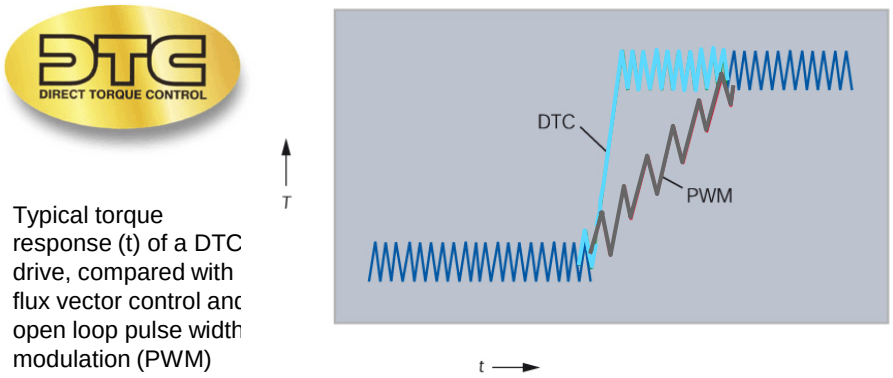
Medium voltage variable speed drives
Mining solutions

- ABB offers special solutions for mining applications, such as underground mining conveyors and armored face conveyors
  - Low-height VSDs, designed for explosion-proof cabinets
  - Ideal solution for harsh environment and limitations in underground mines
  - Meeting the most stringent mining standards

Technology highlights

- Arc fault protection
  - ABB's high-power medium voltage drives are IAC classified
    - Very fast arc detection and elimination
    - Protection of people and equipment, elimination of unnecessary production stops
- Emergency off / emergency stop
  - ABB medium voltage drives are equipped with emergency off / emergency stop functionality
  - SIL (safety integrity level) 3 certification can be provided
- DriveMonitor™ (option)
  - Remote and real-time monitoring and diagnostics of ABB drives from any location in the world
- Direct Torque Control (DTC)
  - For highest torque and speed performance
- Low parts count
  - ABB uses high power semiconductor switching devices and a topology that minimizes the parts count

Direct Torque Control (DTC)



Typical torque response (t) of a DTC drive, compared with flux vector control and open loop pulse width modulation (PWM)

Direct Torque Control

- Provides fast, accurate and stepless control from zero to full speed
- Full torque with optimal speed accuracy over the whole speed range
- Negligibly low torque ripple
- Minimal inverter switching losses at maximal control performance
- High accuracy even without speed encoders

DriveMonitor™
Intelligent monitoring and control

DriveMonitor™ is an intelligent diagnostic system consisting of

- Hardware module (installed in- or outside of drive)
- Software layer (collecting and analyzing selected drive signals and parameters)

Functions

- Monitoring of drive's performance, and, if required, other components (main circuit breaker, transformer, motor)
- Fast fault finding process

High voltage motors

- Induction motors
  - Available up to 25 MW
  - Induction motors are usually the first choice for applications up to 10 MW
- Synchronous motors
  - Typically considered for higher power ratings (e.g. above 8 MW to more than 100 MW)

Input isolation transformers

- Input transformers have several functions, such as:
  - To adjust the network supply voltage to match the converter
  - To provide galvanic isolation between drive and supply network
  - Reduce harmonic distortion
- ABB transformers are available for all ratings and primary voltages, oil or dry type

Testing

ABB is committed to ensuring the reliability of every drive delivered

- Every component of a drive is subjected to thorough testing in ABB's modern test facilities
- Routine tests, functional tests
  - Integral part of the scope of supply
  - Performed in accordance with international standards and ABB quality assurance procedures
- Combined tests
  - Tests with the complete drive system including transformer, converter and motor – can be performed

Worldwide service and support

- Worldwide service network
- 24 x 365 support line
- Local support
- Supervision of installation and commissioning
- System upgrades for optimized operation & migration
- Life cycle management
- Remote diagnostics
- Customized maintenance contracts
- Spare parts and logistics network
- Training

Case example
Pena Colorada, Mexico

The Mexican iron mining company installed a medium voltage drive from ABB, replacing the damper control of its ‘pellet cooling fan’, rated at 1,250 kW

Benefits:

- Energy savings of 23%
- Increased productivity through increased system availability
- Lower motor noise and vibration
- Reduction in service and maintenance costs

Case example
Agnico-Eagle, Canada

Agnico-Eagle's LaRonde mine in Canada produces 260,000 ounces (~7400kg) of gold annually.

In order to run the motor and the SAG mill at the required load output the existing drive was replaced with ABB's ACS 1000 variable speed drive.

Benefits:

- Increased SAG mill output
- Use of existing motor
- High starting torque
- Increased lifetime of equipment
- Low impact of power supply disturbances
- Dependable support and service and reduced maintenance cost

Case example
Grange Resources, Australia

ABB drive systems replaced four slip-ring motors and their variable resistance liquid starters which powered two dual pinion autogenous mills.

ABB supplied four ACS 1000 drive packages (each 2.5 MW) including transformers, medium voltage switchgear and DriveMonitor.

Benefits:

- Monthly energy savings: A$ 15,540 (kUS$ 17)
- Reduction of maintenance requirements
- Optimized plant production
- Smooth start of autogenous mills
- Improved power factor

Case example
Los Colorados, Chile

With the existing gearbox, the nominal motor speed was not high enough to reach the nominal throughput of the conveyor belt at Los Colorados mine.

An ABB medium voltage drive was installed to soft start the motor, allowing a smooth ramp up. The existing gearbox did not need to be replaced and the speed could be increased by almost 25%.

Benefits:

- Improved process control
- Elimination of motor problems
- Longer lifetime of conveyor equipment
- Minimized downtime
- Lower impact on electrical network

Case example
Worsley Alumina, Australia

Bauxite from Worsley Alumina's mine is transported to a refinery 51 km away by a conveyor.

The conveyor was originally driven by DC drives, which did not deliver the required levels of reliability, leading to high maintenance.

The DC technology was underpowered for the requirements of the expansion designed to increase the refinery's capacity.

The replacement resulted in the following benefits:

- Increased conveying capacity
- Improved conveyor control
- Improved start/stop performance
- Reduced maintenance
- Increased availability

Power and productivity
for a better world™